



Geology 12

Examination Booklet

August 2007

Form A

DO NOT OPEN ANY EXAMINATION MATERIALS UNTIL INSTRUCTED TO DO SO.

FOR FURTHER INSTRUCTIONS REFER TO THE RESPONSE BOOKLET.

Contents: 31 pages

64 multiple-choice questions in the Examination Booklet
11 written-response questions in the Response Booklet

Examination: 2 hours

Additional Time Permitted: 60 minutes
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PART A: MULTIPLE CHOICE

Value: 64 marks

Suggested Time: 80 minutes

INSTRUCTIONS: For each question, select the **best** answer and record your choice on the **Answer Sheet** provided. Using an HB pencil, completely fill in the bubble on the **Answer Sheet** that has the letter corresponding to your answer.



Data icons occur throughout the examination to indicate that useful information may be found in the Data Pages to help answer a particular question.

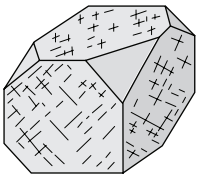
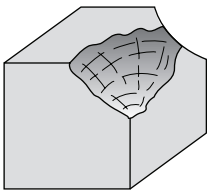
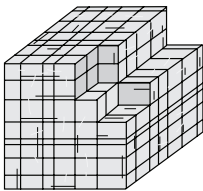
You have **Examination Booklet Form A**. In the box above #1 on your **Answer Sheet**, fill in the bubble as follows.

Exam Booklet Form/ Cahier d'examen	A	B	C	D	E	F	G	H
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- Geologist James Hutton's concept of how Earth's physical features have changed is called *uniformitarianism*. According to this concept, which of the following explains how these changes have occurred?
 - sudden catastrophes
 - hardening of the earth's crust
 - eruptions of ancient volcanoes
 - natural forces which continue to happen
- Which of the following sets of data corresponds to element abundances in the Earth's crust?

	Hydrogen	Oxygen	Silicon	Iron
A.	0.15%	46.00%	27.00%	6.30%
B.	2.40%	41.00%	14.00%	22.00%
C.	75.00%	0.90%	0.09%	0.10%
D.	0.06%	5.80%	0.00%	85.00%

Use the following mineral crystals table to answer questions 3 and 4.

Mineral Crystals	X	Y	Z
			
Colour	purple	brass yellow	metallic grey
Can scratch	copper penny	steel knife	fingernail
Can be scratched by	wire nail	steel knife	fingernail

3. Which mineral property is visible in crystals **X** and **Z** but not visible in crystal **Y**?

- A. lustre
- B. fracture
- C. cleavage
- D. crystal form

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4. Which of the following shows the correct identities of the minerals **X**, **Y** and **Z**?

	X	Y	Z
A.	galena	pyrite	fluorite
B.	fluorite	pyrite	galena
C.	pyrite	galena	fluorite
D.	galena	fluorite	pyrite

Data
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5. The mineral specimen shown in the photograph can be scratched by a copper penny and fizzes in acid. What mineral is it?

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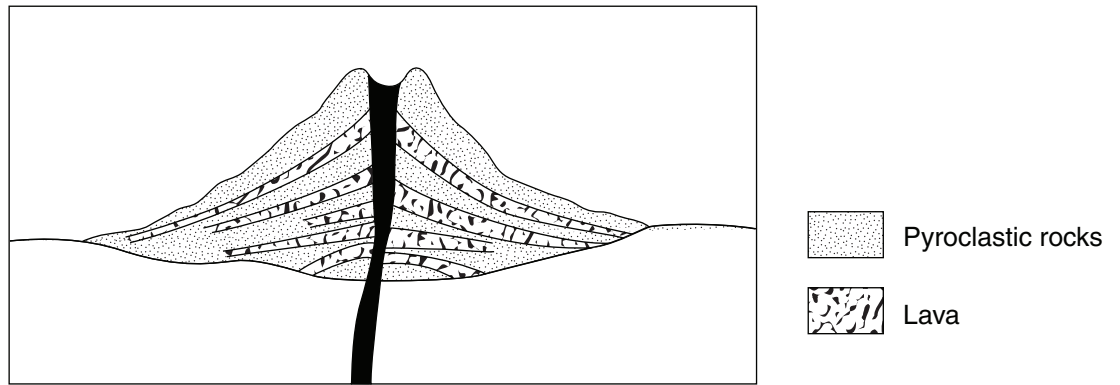
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- A. halite
B. quartz
C. calcite
D. gypsum
6. A granite contains the minerals quartz, muscovite mica, potassium feldspar and plagioclase feldspar. Which mineral is the easiest to scratch?
- A. quartz
B. muscovite mica
C. potassium feldspar
D. plagioclase feldspar

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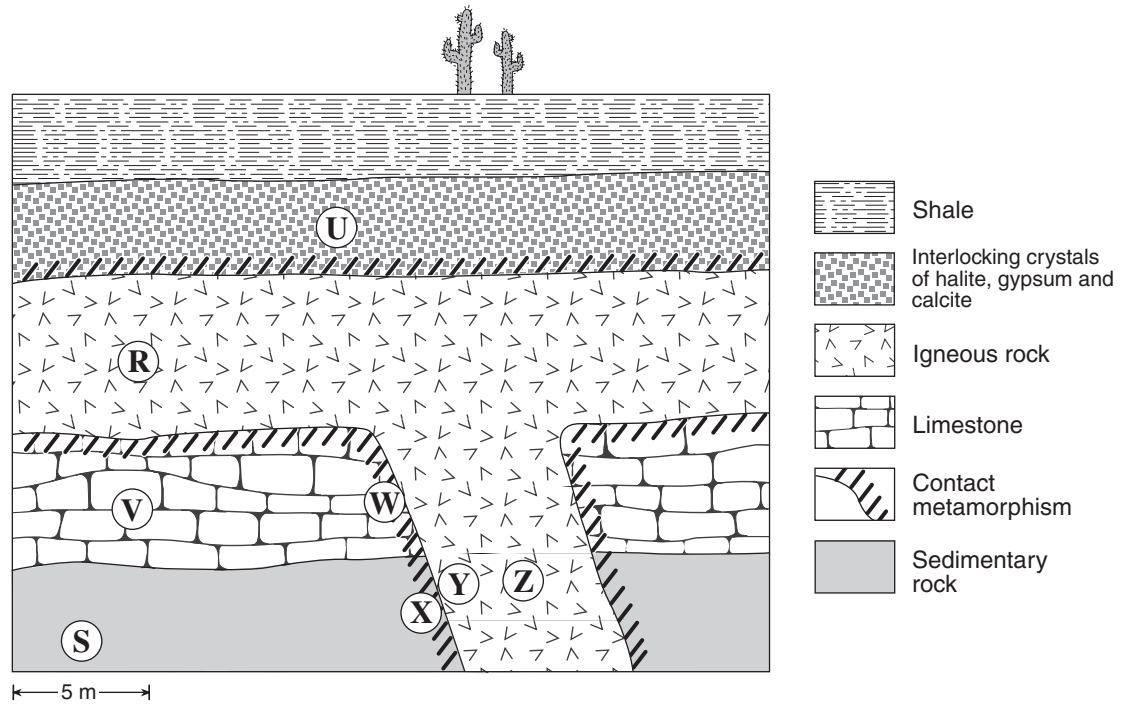
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Use the following diagram of the cross section of a volcano to answer questions 7 and 8.



7. Which type of volcano is shown in the diagram?
- A. shield
 - B. plateau
 - C. lava dome
 - D. composite cone
8. Which of the following lavas would **most likely** be produced during an eruption of this volcano?
- A. mafic with low viscosity
 - B. silicic with low viscosity
 - C. mafic with high viscosity
 - D. silicic with high viscosity

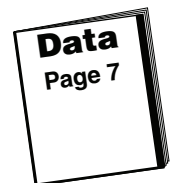
Use the following cross section to answer questions 9 to 14.



9. What name would be given to the igneous structure at **R**?
 - A. sill
 - B. dike
 - C. stock
 - D. lava flow

10. The range of crystal sizes at **Z** is 1.0–2.0 mm. What is the **most likely** range of crystal sizes at **Y**?
 - A. 0.1–0.5 mm
 - B. 1.0–2.0 mm
 - C. 1.0–5.0 mm
 - D. 3.0–5.0 mm

11. The rock at **R** is composed mostly of dark ferromagnesians and plagioclase feldspar, with a little potassium feldspar and quartz. Name the rock.
 - A. basalt
 - B. diorite
 - C. granite
 - D. rhyolite



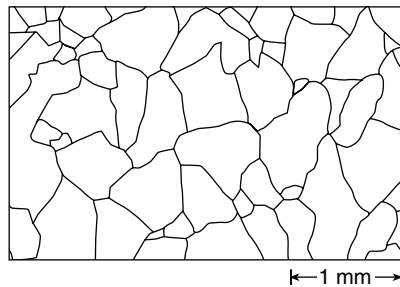
12. What type of material composes unit **U**?

- A. clastic
- B. organic
- C. igneous
- D. evaporite

13. The rock at **V** is limestone. What is the rock at **W**?

- A. schist
- B. gneiss
- C. marble
- D. quartzite

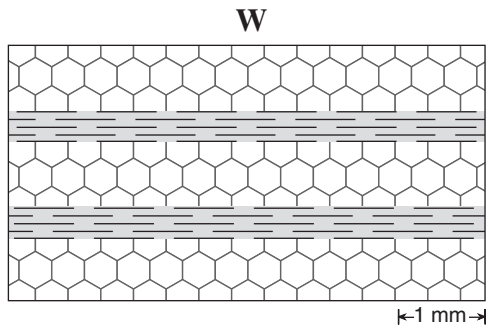
14. The rock at **X** is composed of crystals of quartz with an interlocking texture, as shown below.



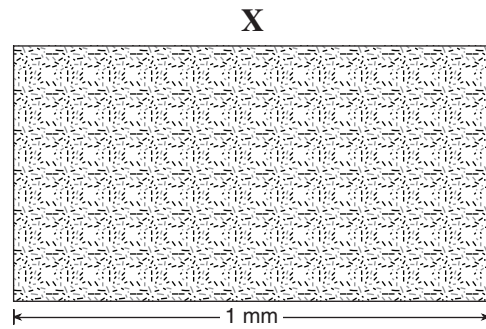
Which of the following descriptions would **best** describe the sedimentary rock at **S**?

- A. randomly oriented clay minerals
- B. angular, interlocking crystals of calcite
- C. rounded grains of quartz cemented together
- D. interlocking crystals of quartz, feldspars and amphibole

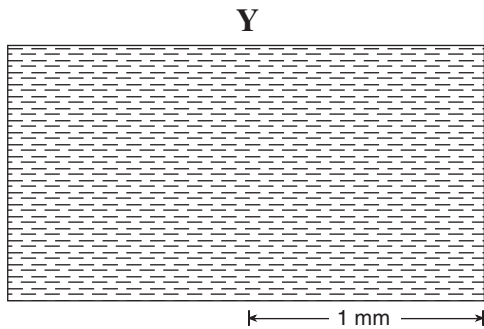
Use the following sketches of one sedimentary and three regional metamorphic rock textures to answer question 15.



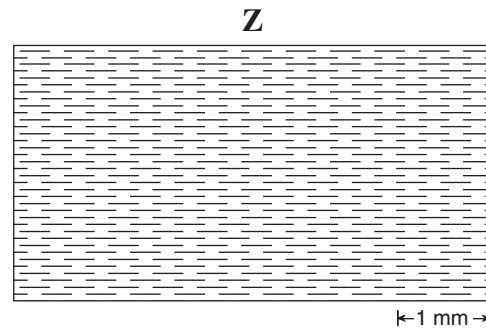
Very large crystals, bands of quartz and feldspars alternating with biotite mica



Very small, randomly oriented clay minerals



Small muscovite mica minerals with parallel orientation

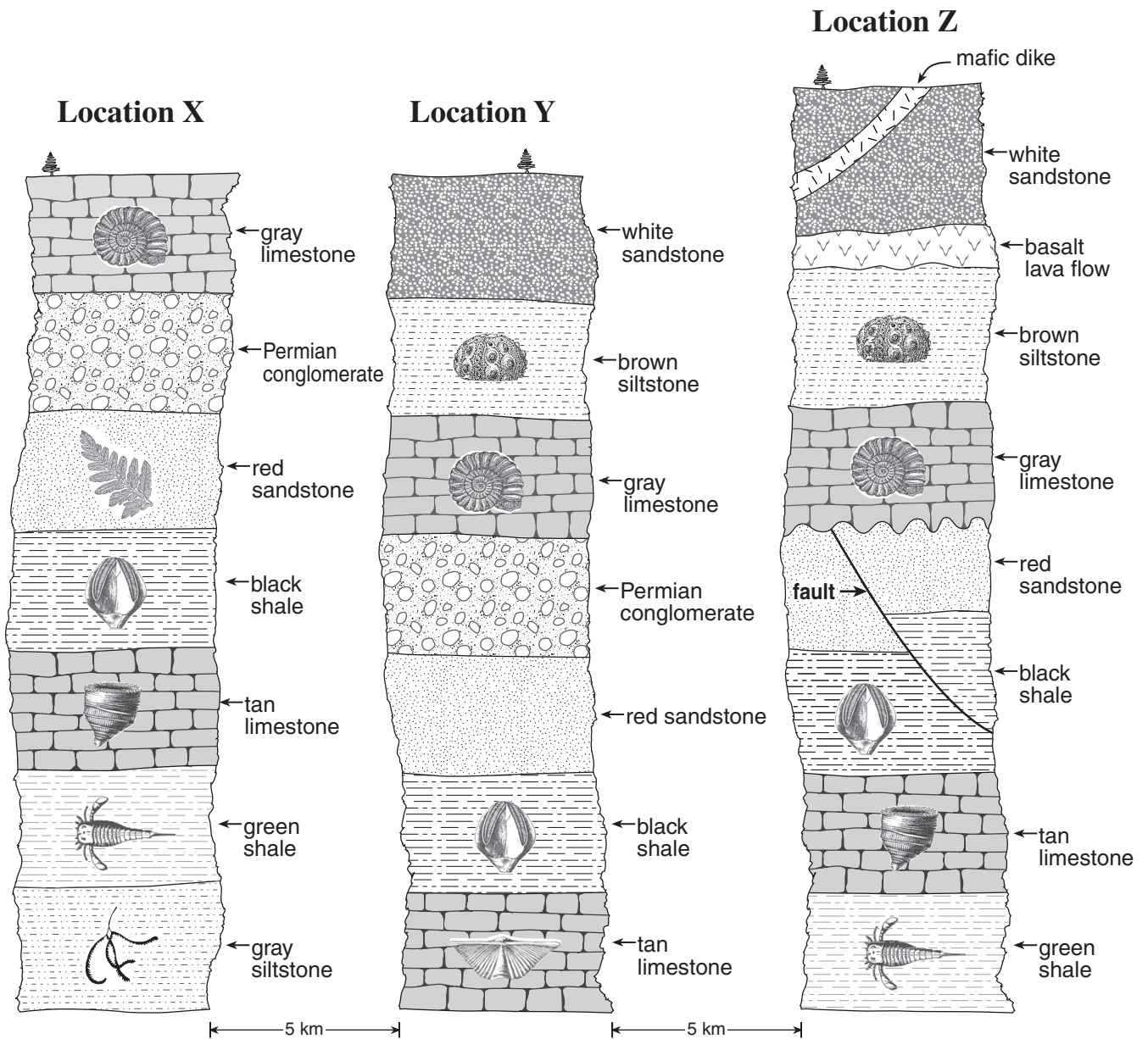


Large muscovite mica crystals with parallel orientation

15. Put these textures in order of increasing metamorphic grade.

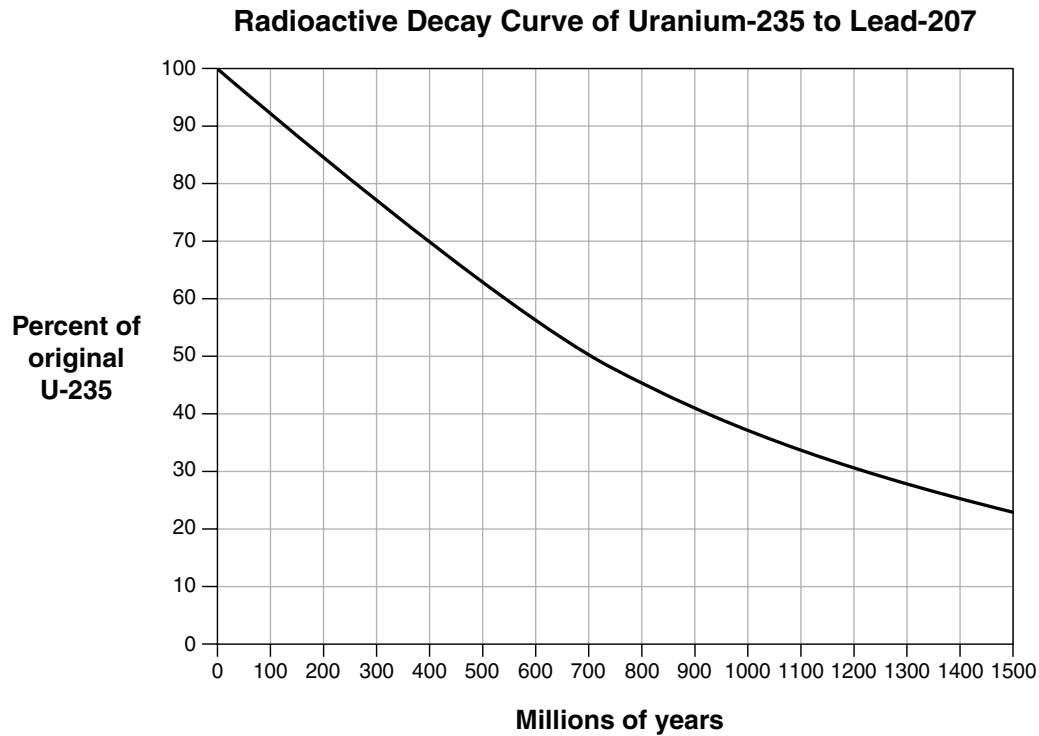
- A. W, X, Y, Z
- B. W, Z, Y, X
- C. X, Z, Y, W
- D. X, Y, Z, W

Use the following geologic columns to answer questions 16 to 20.
Each sedimentary rock layer represents a different geological period.



Fossils not drawn to scale.

Use the following graph to answer question 16.



16. The basalt lava flow at **Location Z** has been dated using the Uranium-235 /Lead-207 radiometric dating technique. It was found to contain 92% of its original Uranium-235. Using the radioactive decay graph, determine the **most likely** radiometric age of the basalt lava flow.

- A. 50 million years
- B. 100 million years
- C. 150 million years
- D. 200 million years



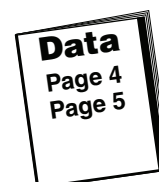


17. The mafic dyke at **Location Z** has been dated at 70 million years. Which of the following is the **most likely** age of the white sandstone in **Location Y**?

- A. Tertiary
- B. Triassic
- C. Jurassic
- D. Cretaceous

18. What is the oldest rock layer shown in any of the columns **X**, **Y** and **Z**?

- A. green shale
- B. gray siltstone
- C. tan limestone
- D. white sandstone

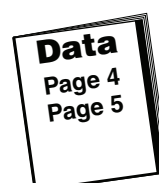


19. Which of the following events is marked by the boundary between the gray limestone and the Permian conglomerate at **Location X**?

- A. beginning of the Cenozoic Era
- B. beginning of the Mesozoic Era
- C. beginning of the Paleozoic Era
- D. beginning of the Precambrian Era

20. During which of the following periods did the faulting at **Location Z** occur?

- A. Jurassic
- B. Permian
- C. Mississippian
- D. Devonian



Refer to the Mississippian Age Rock Outcrops with Fossils on page 11
and the Mississippian Fossils and their Environments on page 12
of the Data Pages to answer questions 21 to 25.

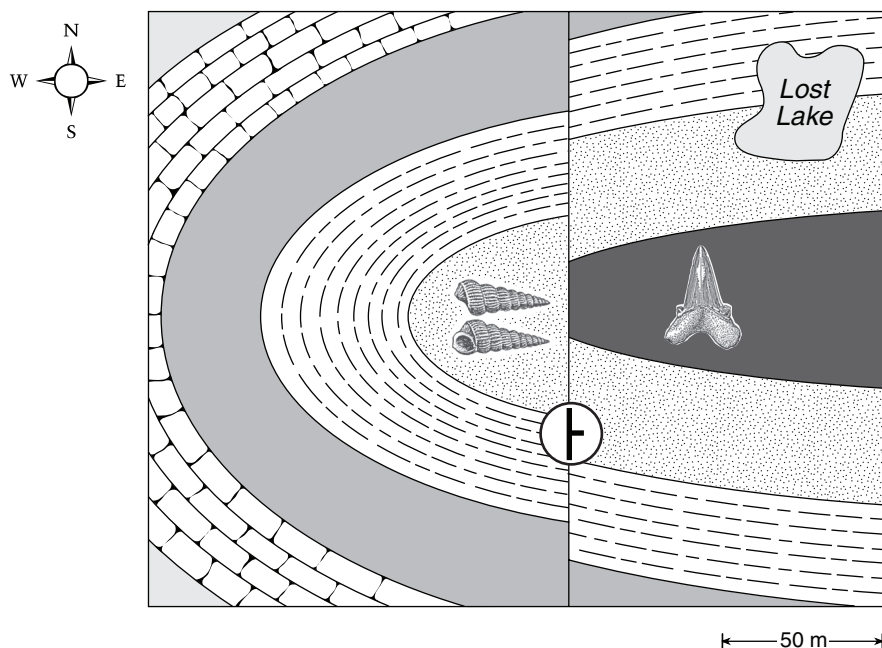
Data
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Rock outcrop locations **R, S, T, U, V** and **W** are found along a 400 km length of relatively straight highway. The sedimentary rocks and the fossils they contain are all of the same Mississippian age.

21. Which location contains rocks and fossils which were originally deposited in the deepest water?
- A. the shale at Location U
 - B. the limestone at Location S
 - C. the coal and shale at Location R
 - D. the shale and sandstone at Location T
22. The foraminiferan is the most useful index (guide) fossil of those shown. What is the reason for this?
- A. It is extinct.
 - B. It is easily preserved.
 - C. It lived during the Paleozoic era.
 - D. It is the most geographically widespread.
23. Which of the following organisms has left a trace fossil?
- A. crinoid
 - B. trilobite
 - C. amphibian
 - D. cephalopod
24. All of the fossils shown in the diagrams were organisms that became extinct at the end of the Mississippian period. Most of the fossils were also found in a younger Pennsylvanian rock layer lying directly on top of the Mississippian layer. Which of the following Pennsylvanian rock types is **most likely** to contain these Mississippian fossils?
- A. black shale
 - B. coral-rich limestone
 - C. fine-grained sandstone
 - D. boulder-rich conglomerate
25. Which of the fossils, shown in the diagrams, is most closely related to modern crabs?
- A. coral
 - B. trilobite
 - C. amphibian
 - D. cephalopod

26. At the end of the Cretaceous period, 70% to 80% of all species on Earth became extinct, perhaps due to an asteroid impact. Which of the following is a major group of organisms that have been increasingly dominant from the end of the Permian to the present?
- trilobites
 - dinosaurs
 - mammals
 - brachiopods

Use the following map to answer questions 27 and 28.



27. Which of the following describes the strike and dip of the fault?

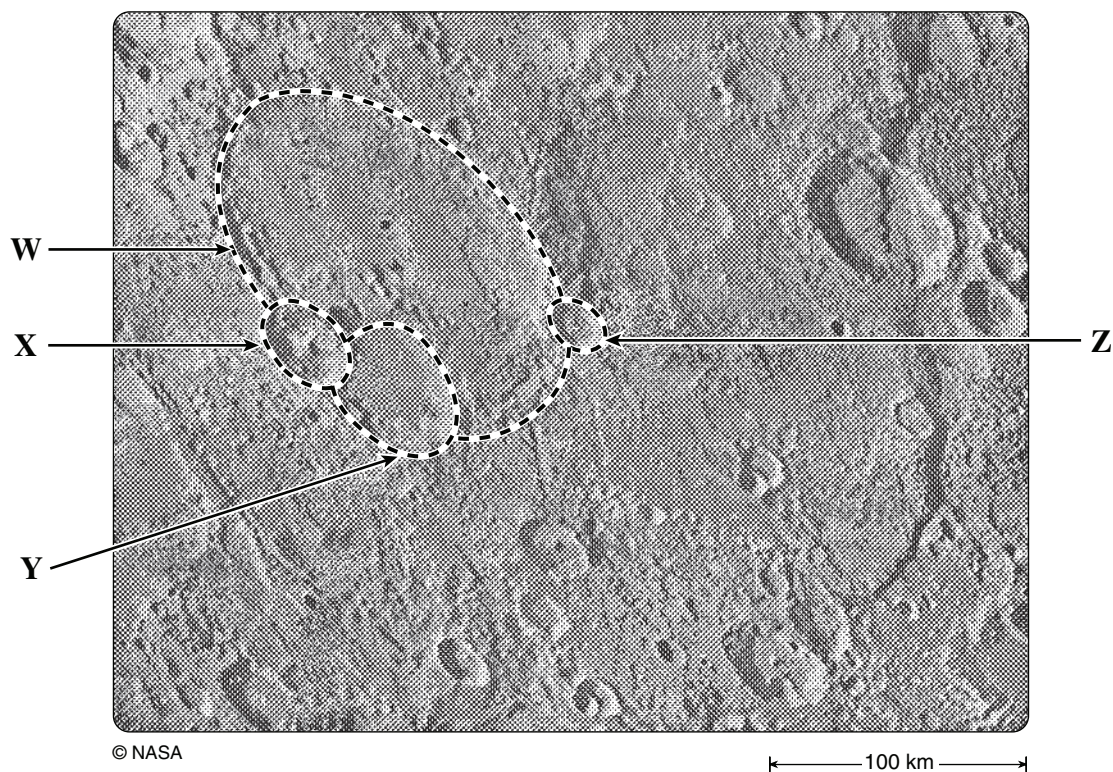
	Strike	Dip
A.	north-south	west
B.	north-south	east
C.	east-west	north
D.	east-west	south

28. What type of fold is visible on the map?

- plunging syncline
- plunging anticline
- non-plunging syncline
- non-plunging anticline

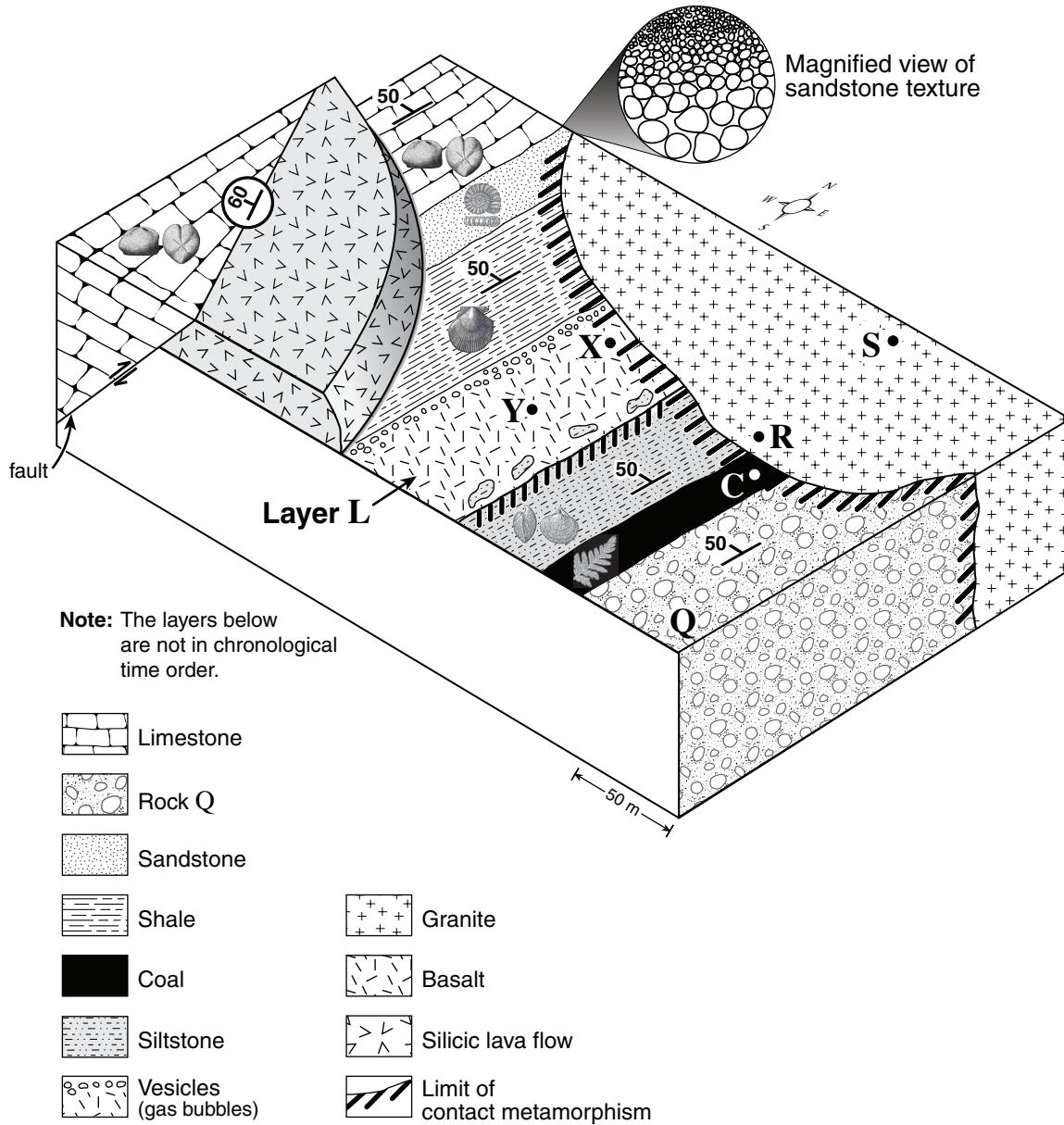
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Use the following photograph to answer question 29.



29. The photograph shows craters on the surface of the moon. Which of the labelled features is the oldest?
- A. W
 - B. X
 - C. Y
 - D. Z

Use the following geological block diagram to answer questions 30 to 32.

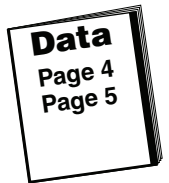


30. Which of the following principles can **best** be used to determine the age of the granite relative to the sedimentary rock layers?

- A. superposition
- B. faunal succession
- C. original horizontality
- D. cross-cutting relations

31. Which of the following is the youngest sedimentary rock layer shown in the block diagram?

- A. coal
- B. shale
- C. limestone
- D. sandstone



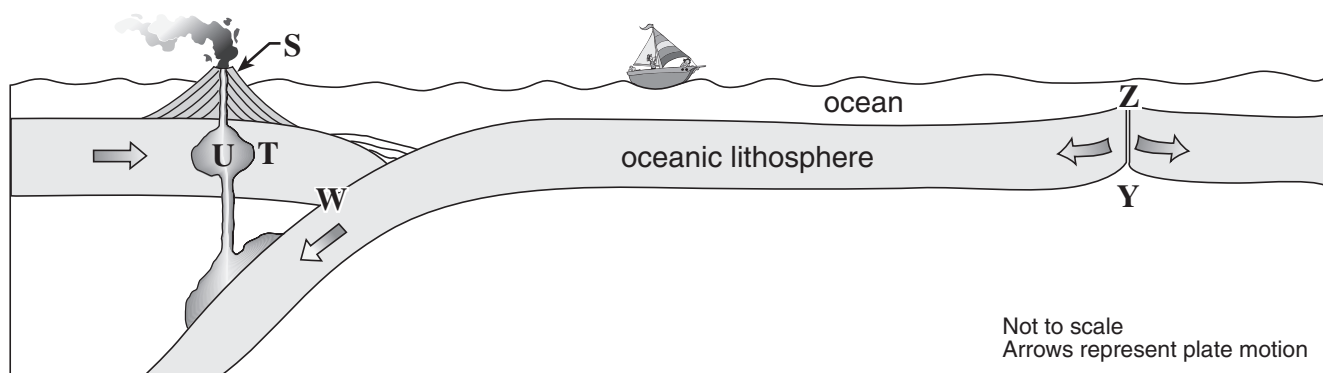
32. Samples **X** and **Y** from the basalt lava have been radiometrically dated using the K40/Ar40 method. Sample X was dated to be 50 m.y. younger than sample Y. Which of the following is the **most likely** reason for the apparent difference in dates?

- A. The lava at X and Y erupted at different times.
- B. Weathering has added Potassium-40 to sample X.
- C. Sample Y has been faulted upwards from lower in the sequence.
- D. Heat from the granite has allowed Argon-40 to escape from sample X.

33. Recent data suggest that movement of lithospheric plates may be a result of gravity pulling on subducting plates. In contrast, what is the traditional explanation for plate motion?

- A. convection cells in the mantle
- B. magma cycling in the outer core
- C. rocks sinking in mantle hot spots
- D. differential heating between lithospheric volcanoes

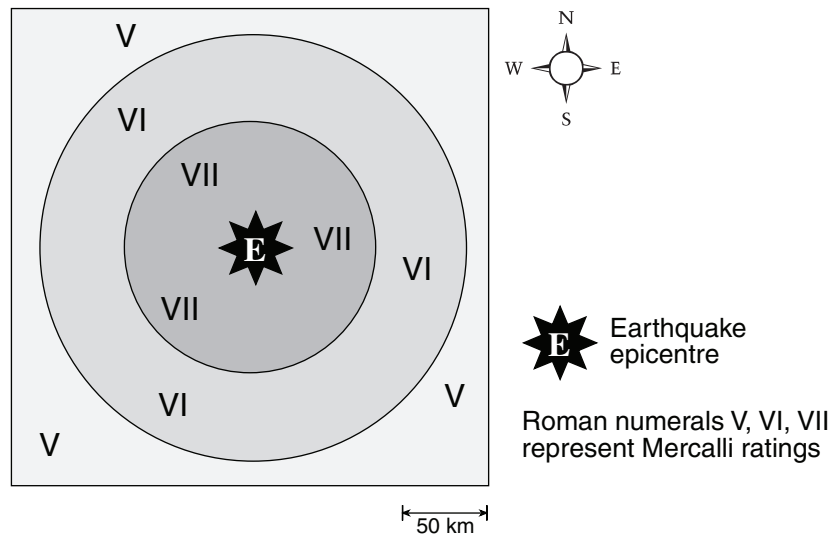
Use the following cross section to answer questions 34 to 37.



34. What type of **plate boundary** is located at **Z**?
- A. divergent
 - B. transform
 - C. subduction
 - D. convergent
35. What feature is located at **S**?
- A. a fold mountain
 - B. a hot spot volcano
 - C. an island arc volcano
 - D. a mid-ocean ridge volcano
36. At which location is the **largest** magnitude earthquake most likely?
- A. T
 - B. U
 - C. W
 - D. Y
37. At which location would **metamorphic rock** most likely form?
- A. S
 - B. T
 - C. U
 - D. Y

38. Along transform plate boundaries, fault creep may occur continuously. What other geological process may also occur?
- A. large scale folding
 - B. large scale crustal uplift
 - C. many small earthquakes
 - D. composite cone volcanoes

Use the following map of intensities felt over a large region, resulting from an earthquake at E, to answer question 39.



39. What is the most important factor in determining the **intensity** pattern resulting from earthquake E?
- A. rock types
 - B. ground strength
 - C. construction design
 - D. distance from the epicentre
-
40. How much more **ground motion** is released during a magnitude 7 earthquake than its magnitude 5 aftershock?
- A. 2 times
 - B. 10 times
 - C. 100 times
 - D. 1000 times

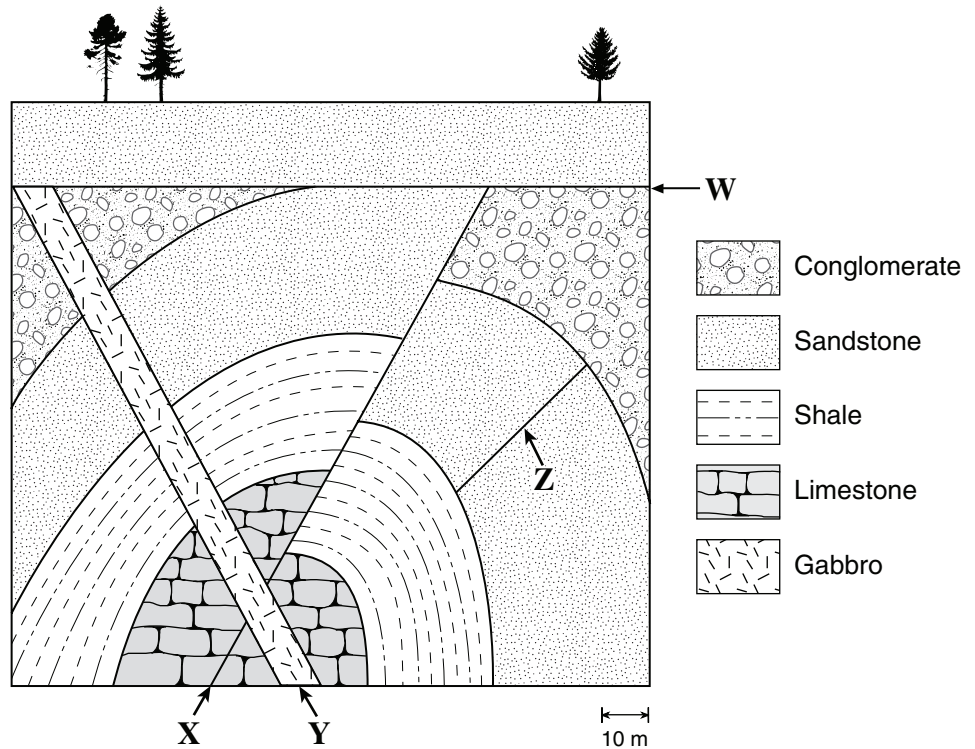
41. Which of the following is the **best** evidence that Earth's core can be divided into two parts?
- A. The inner core is cooler than the outer core.
 - B. Earth's magnetic field comes from the inner core.
 - C. S-waves slow down as they enter the denser inner core.
 - D. P-waves speed up suddenly when they enter the inner core.

Use the following list of Earth's layers to answer questions 42 and 43.

Earth's layers
atmosphere
hydrosphere (oceans)
crust
mantle
outer core
inner core

42. The correct order of the Earth's layers is listed above. Which of the following properties is most important in causing the layers to be arranged in this order?
- A. density
 - B. pressure
 - C. temperature
 - D. physical state (i.e. solid, liquid or gas)
43. Which layers are mainly liquid?
- A. mantle and crust
 - B. crust and outer core
 - C. mantle and hydrosphere
 - D. hydrosphere and outer core

Use the following cross section to answer question 44.



44. Which of the labelled features above represents a joint?

- A. W
- B. X
- C. Y
- D. Z

Use the following photograph and geologic cross section of a typical mountain in the Rocky Mountains to answer questions 45 and 46.

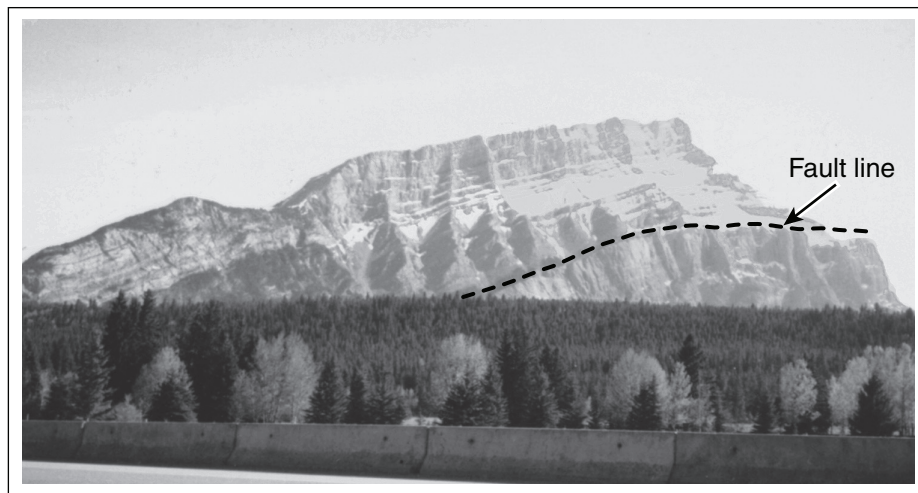
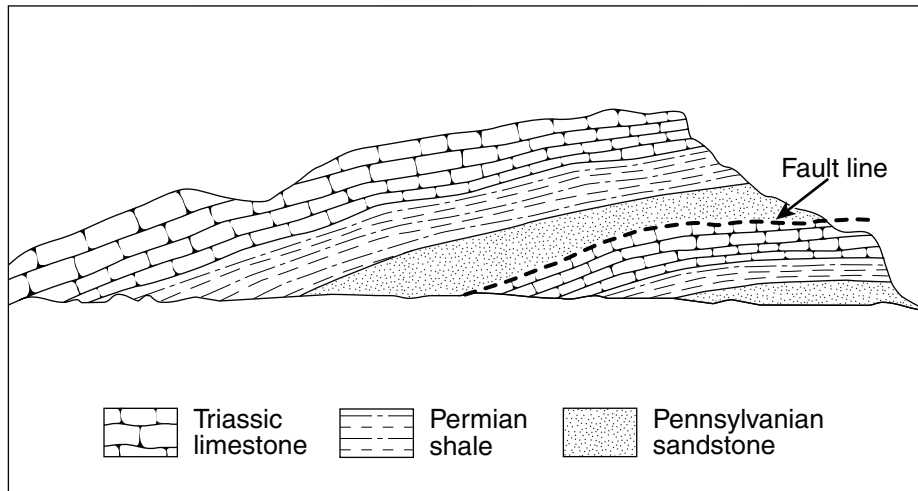


Photo courtesy of T.J. Visuals



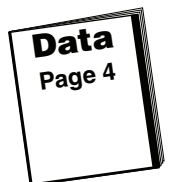
45. What type of fault is shown?

- A. thrust
- B. normal
- C. strike slip
- D. transform



46. What type of force created the fault?

- A. shear
- B. tensional
- C. gravitational
- D. compressional



47. All of the inner planets and moons were heavily cratered by planetoid impacts during their creation. Which of the following is a reason why Earth's moon has many more impact craters than Earth?
- A. The Moon is a smaller target than Earth.
 - B. Earth was sheltered from impacts by the Moon.
 - C. Earth is more geologically active than the Moon.
 - D. The Moon has a weaker gravitational pull than Earth.
48. Which of the following bodies of the inner solar system shows past evidence of river, wind, glacial and volcanic processes?
- A. Mars
 - B. Venus
 - C. Mercury
 - D. Earth's moon
49. Which of the following structures **best** shows the farthest advance of a glacier?
- A. lateral moraine
 - B. ground moraine
 - C. terminal moraine
 - D. recessional moraine
50. All of the following features are associated with glaciation. Which of the features may show cross bedding?
- A. horn
 - B. esker
 - C. cirque
 - D. ground moraine

Use the following photograph to answer question 51.



© A. Sedgwick

51. Which of the following geological processes is mostly responsible for the landscape seen in the photograph?
- A. shield volcanism
 - B. abrasion by wind
 - C. erosion by glaciers
 - D. deposition by rivers

Use the following photograph to answer question 52.



© A. Sedgwick

52. Which of the following glacial features is shown in the photograph?
- A. erratic
 - B. drumlin
 - C. end moraine
 - D. kame terrace

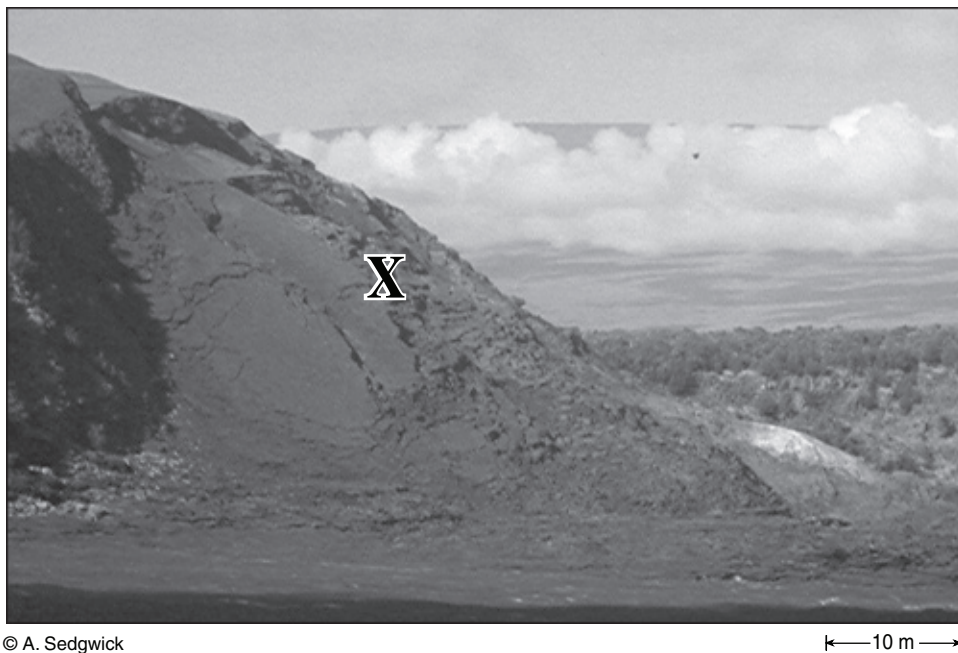
Use the following photograph to answer question 53.



© T. Janson

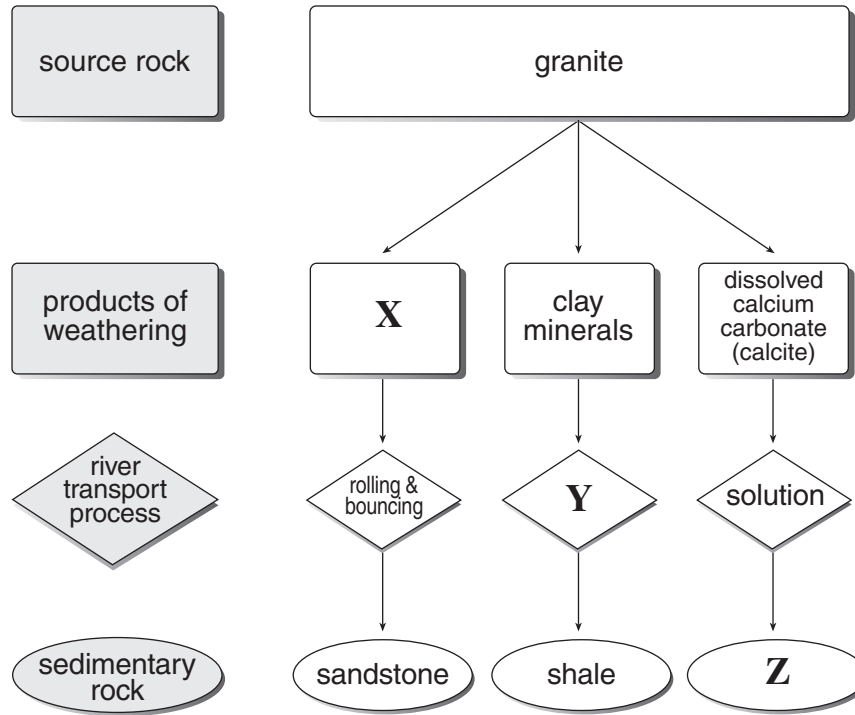
53. The tilted rock layers may slide onto the road. Which of the following methods will **best** stabilize the tilted rock layers?
- A. bolting the rock layers together
 - B. adding a sand layer to the slope
 - C. watering the trees at the top of the slope
 - D. removing some of the rock at the bottom of the slope

Use the following photograph to answer question 54.



54. What geological process is responsible for the earth movements visible in area **X**?
- A. isostasy
 - B. glaciation
 - C. subduction
 - D. mass wasting

Use the following diagram to answer questions 55 to 57.



55. Which of the following processes would be most important in forming new minerals from the granite?

- A. exfoliation
- B. ice wedging
- C. chemical weathering
- D. physical weathering

Data
Page 6
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56. Mineral **X** is often the only remaining mineral after intense weathering of a granite. What is the **most likely** identity of mineral **X**?

- A. pyrite
- B. biotite
- C. olivine
- D. quartz

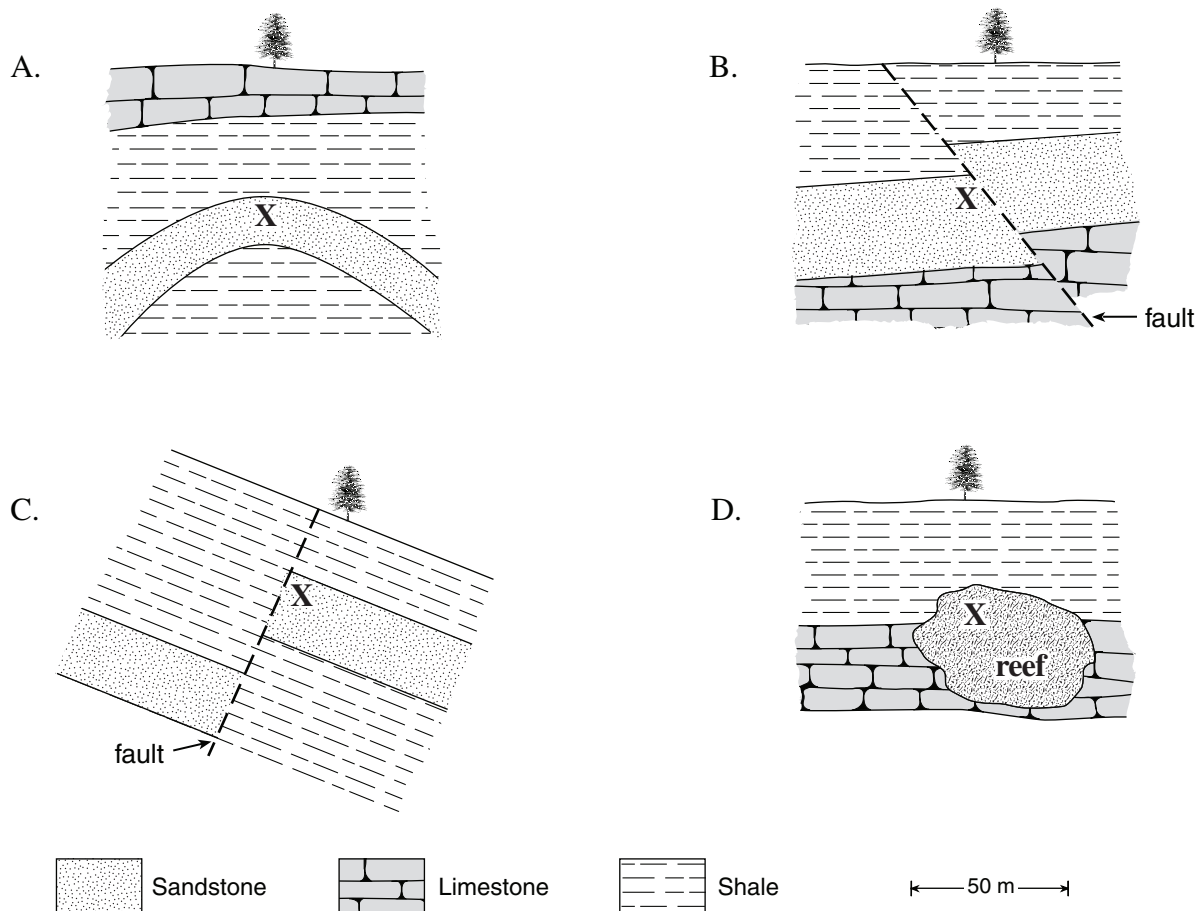
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57. What name would be given to river transport process **Y**?

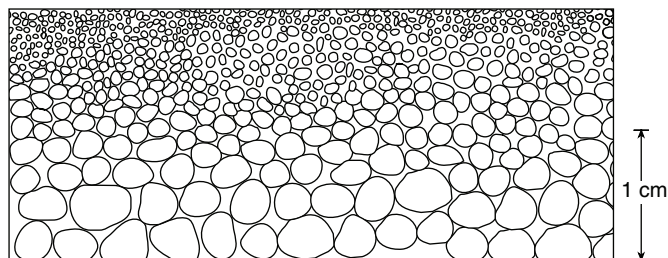
- A. rolling
- B. solution
- C. saltation
- D. suspension

58. Which of the following processes is associated with the formation of hydrothermal mineral deposits in oceanic crust?
- A. magmatic assimilation in batholiths
 - B. seawater evaporation in ocean basins
 - C. hot water convection at sea floor rifts
 - D. contact metamorphism around plutons
59. Which of the following economic minerals is commonly concentrated by evaporation of a lake or sea?
- A. galena
 - B. gypsum
 - C. molybdenite
 - D. chalcopryrite
60. Which of the following is an ore mineral that is an important source of zinc?
- A. garnet
 - B. quartz
 - C. calcite
 - D. sphalerite

61. An **X** marks the location of a possible oil trap in each cross section.
Which of the following locations is **least likely** to act as a trap for oil and gas?



Use the following cross-sectional diagram to answer questions 62 and 63.



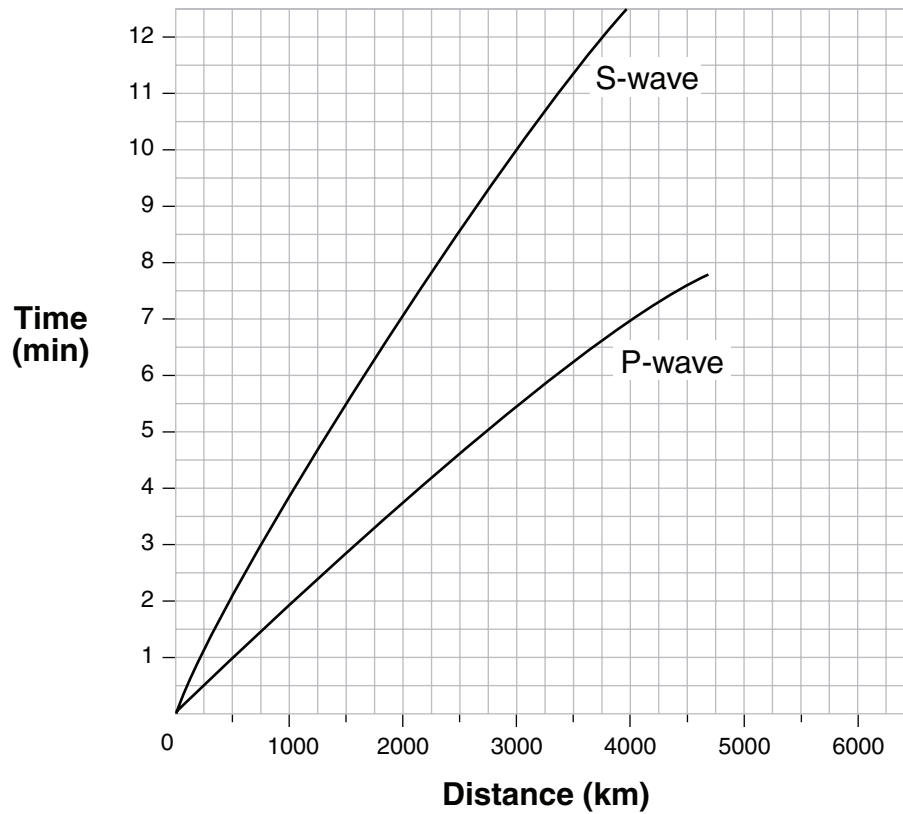
62. What name is given to the sedimentary structure shown in the diagram above?
- A. mud cracks
 - B. ripple marks
 - C. cross bedding
 - D. graded bedding
63. What changes in stream conditions caused the deposition of the particles in the sediment?
- A. an increase in gradient
 - B. a decrease in stream width
 - C. a decrease in stream velocity
 - D. an increase in water temperature
- _____
64. Which of the following features would **most likely** be found in a sandstone layer if it was formed from wind-blown sands?
- A. mud particles
 - B. gabbro pebbles
 - C. bivalve burrows
 - D. rounded quartz grains

You have **Examination Booklet Form A**. In the box above #1 on your **Answer Sheet**, ensure you filled in the bubble as follows.

Exam Booklet Form/ Cahier d'examen	A	B	C	D	E	F	G	H
	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

This is the end of the multiple-choice section.
Answer the remaining questions directly in the Response Booklet.

P- and S- Seismic Wave Travel Time Graph

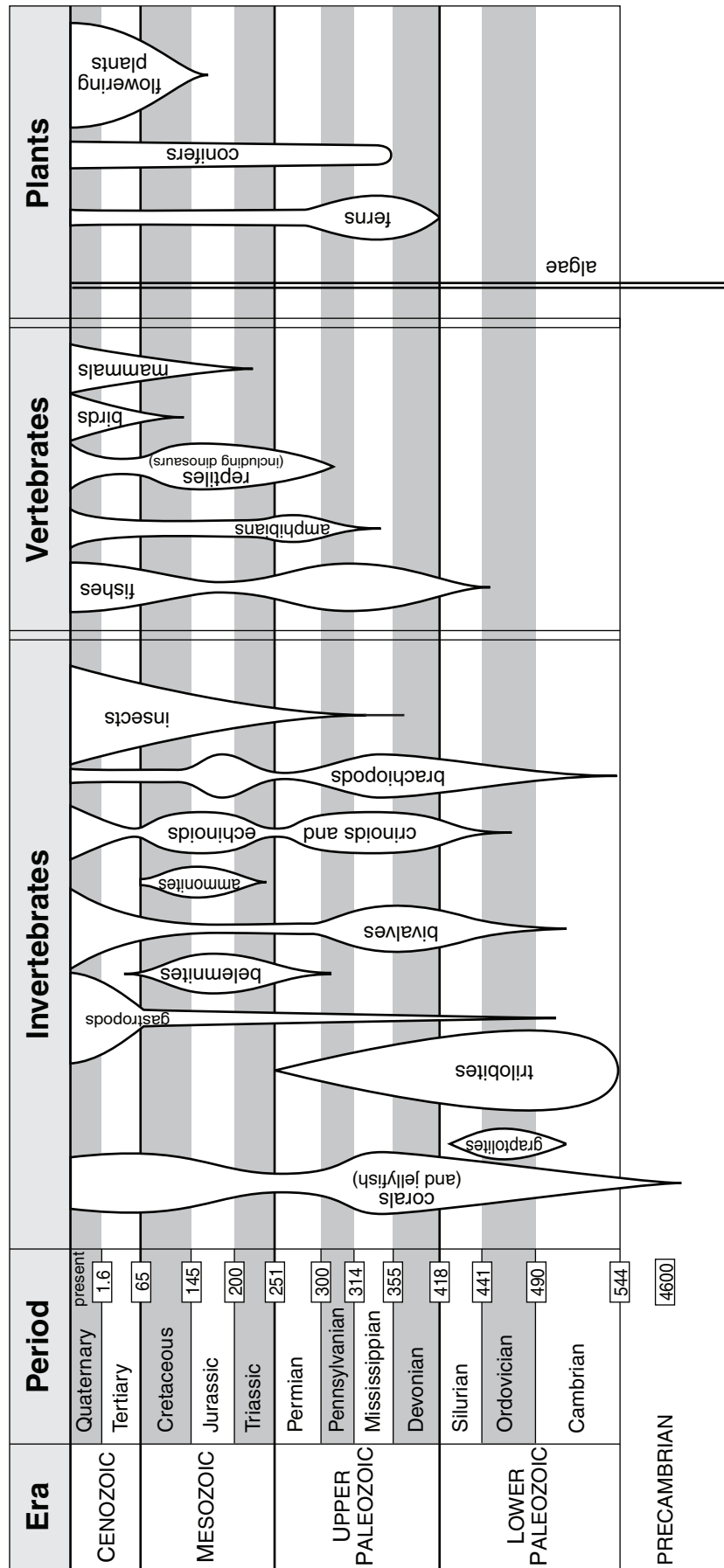


Modified Mercalli Scale

Rating	Description
I	Barely felt.
II	Felt by a few sensitive people, some suspended objects may swing.
III	Slightly felt indoors as though a large truck were passing.
IV	Felt indoors by many people, most suspended objects swing, windows and dishes rattle, standing autos rock.
V	Felt by almost everyone, sleeping people are awakened, dishes and windows break.
VI	Felt by everyone, some are frightened and run outside, some have trouble walking, some chimneys break, some furniture moves, slight damage.
VII	Considerable damage in poorly-built structures, felt by people driving, most are frightened and run outside.
VIII	Slight damage to well-built structures, poorly-built structures are heavily damaged, walls, chimneys, monuments fall.
IX	Underground pipes break, foundations of buildings are damaged and buildings shift off foundations, considerable damage to well-built structures.
X	Few structures survive, most foundations destroyed, water moved out of banks of rivers and lakes, avalanches and rockslides, railroads are bent.
XI	Few structures remain standing, total panic, large cracks in the ground.
XII	Total destruction, objects thrown into the air, the land appears to be liquid and is visibly rolling like waves.

Development of Life through Time

The life-span of each group is shown. The species abundance of each group is shown by the thickness of the column.



Geological Time Scale

Era	Period		Epoch	Time (m.y.)
Cenozoic	Quaternary		Holocene	0.01
			Pleistocene	1.6
	Tertiary		Pliocene	5.3
			Miocene	24
			Oligocene	34
			Eocene	55
			Paleocene	65
Mesozoic	Cretaceous			145
	Jurassic			200
	Triassic			251
	Permian			300
Paleozoic	Carboniferous	Pennsylvanian		314
		Mississippian		355
	Devonian			418
	Silurian			441
	Ordovician			490
	Cambrian			544
				4600
Precambrian				

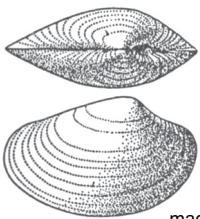


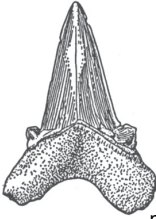
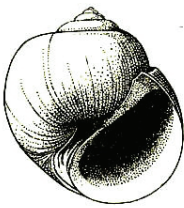
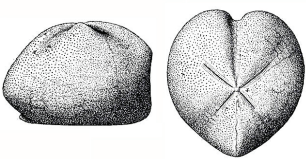

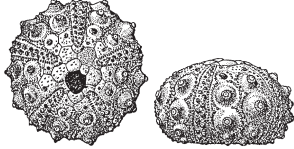

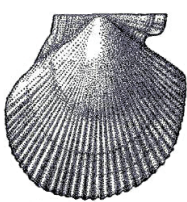


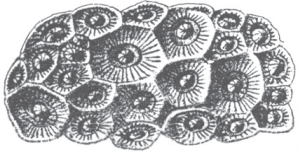
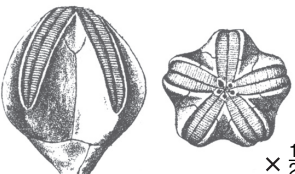
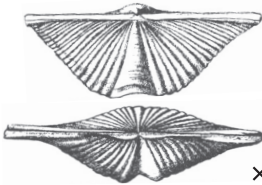

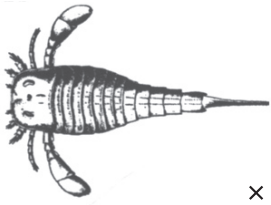


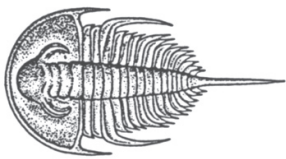
Dates according to Geological Time Scale, 1999. Geological Survey of Canada Open File 3040.
It is recognized that there is some variation in the dates given in the literature.

Isotope Pairs Used for Radiometric Dating

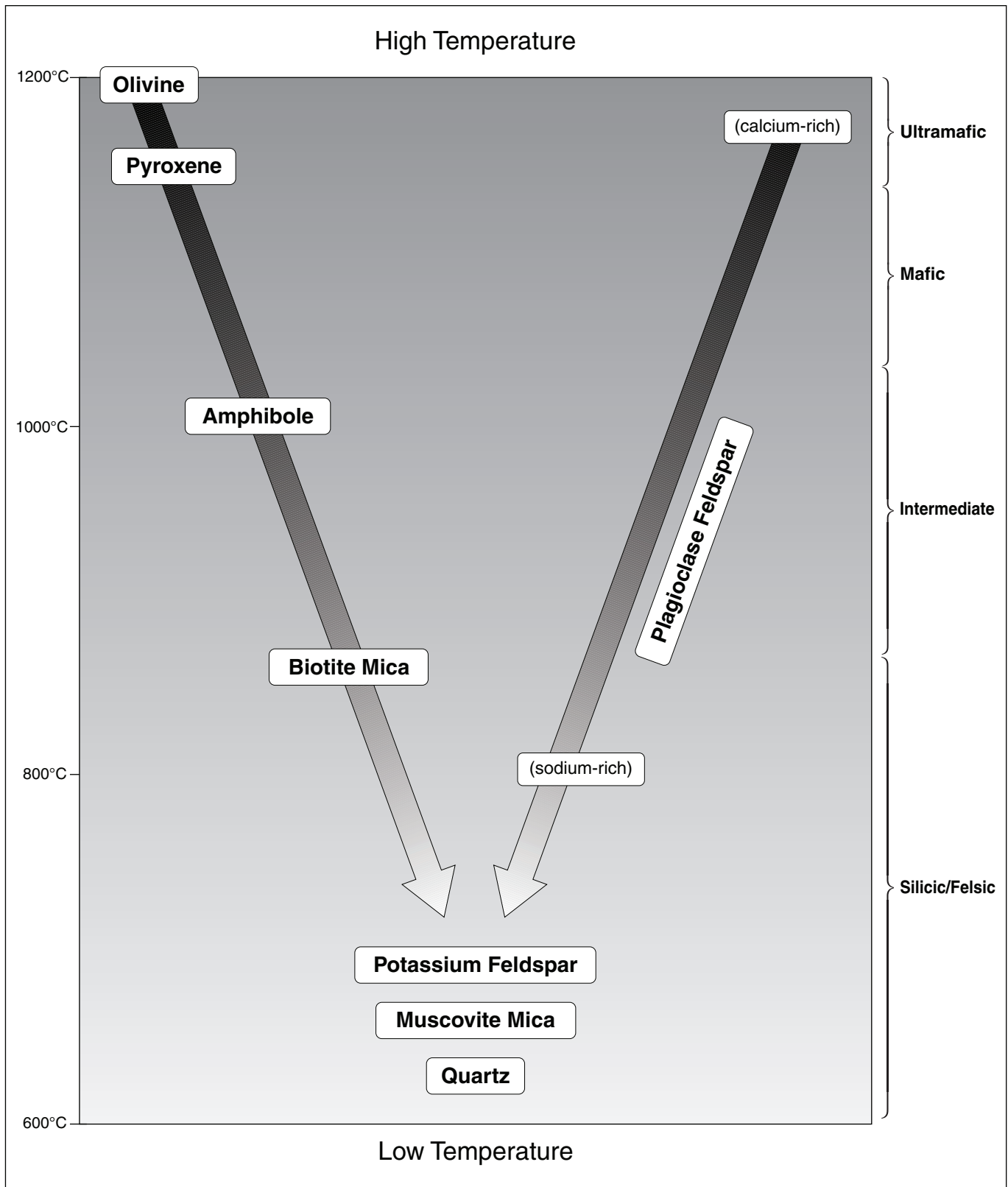
Isotope		Half-life of Parent (years)	Effective Dating Range (years)
Parent	Daughter		
Uranium-238	Lead-206	4.5 billion	1 million to 4.5 billion
Rubidium-87	Strontium-87	48.8 billion	10 million to 4.5 billion
Potassium-40	Argon-40	1.3 billion	10 000 to 3 billion
Uranium-235	Lead-207	715 million	10 million to 4.6 billion
Carbon-14	Nitrogen-14	5730	< 100 000

Source: Carl Zimmer, National Geographic, September 2001

Fossil Samples

<p>1 Tertiary (Miocene)</p>  <p>× $\frac{1}{2}$ magnification</p>	<p>2 Tertiary (Oligocene)</p>  <p>× 1 magnification</p>	<p>3 Tertiary (Eocene to Holocene)</p>  <p>× 45 magnification</p>	<p>4 Tertiary (Eocene)</p>  <p>× $\frac{1}{2}$ magnification</p>
<p>5 Tertiary (Paleocene)</p>  <p>× 1 magnification</p>	<p>6 Cretaceous</p>  <p>× 3 magnification</p>	<p>7 Jurassic to Holocene</p>  <p>× $\frac{1}{2}$ magnification</p>	<p>8 Jurassic</p>  <p>× $\frac{1}{4}$ magnification</p>
<p>9 Triassic</p>  <p>× $\frac{1}{2}$ magnification</p>	<p>10 Permian</p>  <p>× $\frac{1}{2}$ magnification</p>	<p>11 Permian</p>  <p>× $\frac{1}{2}$ magnification</p>	<p>12 Pennsylvanian</p>  <p>× $\frac{1}{2}$ magnification</p>
<p>13 Mississippian</p>  <p>× $\frac{1}{2}$ magnification</p>	<p>14 Mississippian</p>  <p>× $\frac{1}{2}$ magnification</p>	<p>15 Devonian</p>  <p>× $\frac{1}{2}$ magnification</p>	<p>16 Devonian</p>  <p>× 1 magnification</p>
<p>17 Silurian</p>  <p>× $\frac{1}{4}$ magnification</p>	<p>18 Ordovician to Devonian</p>  <p>× 25 magnification</p>	<p>19 Ordovician</p>  <p>× $\frac{1}{2}$ magnification</p>	<p>20 Cambrian</p>  <p>× $\frac{1}{2}$ magnification</p>

Bowen's Reaction Series



Percentage of Minerals in Igneous Rocks

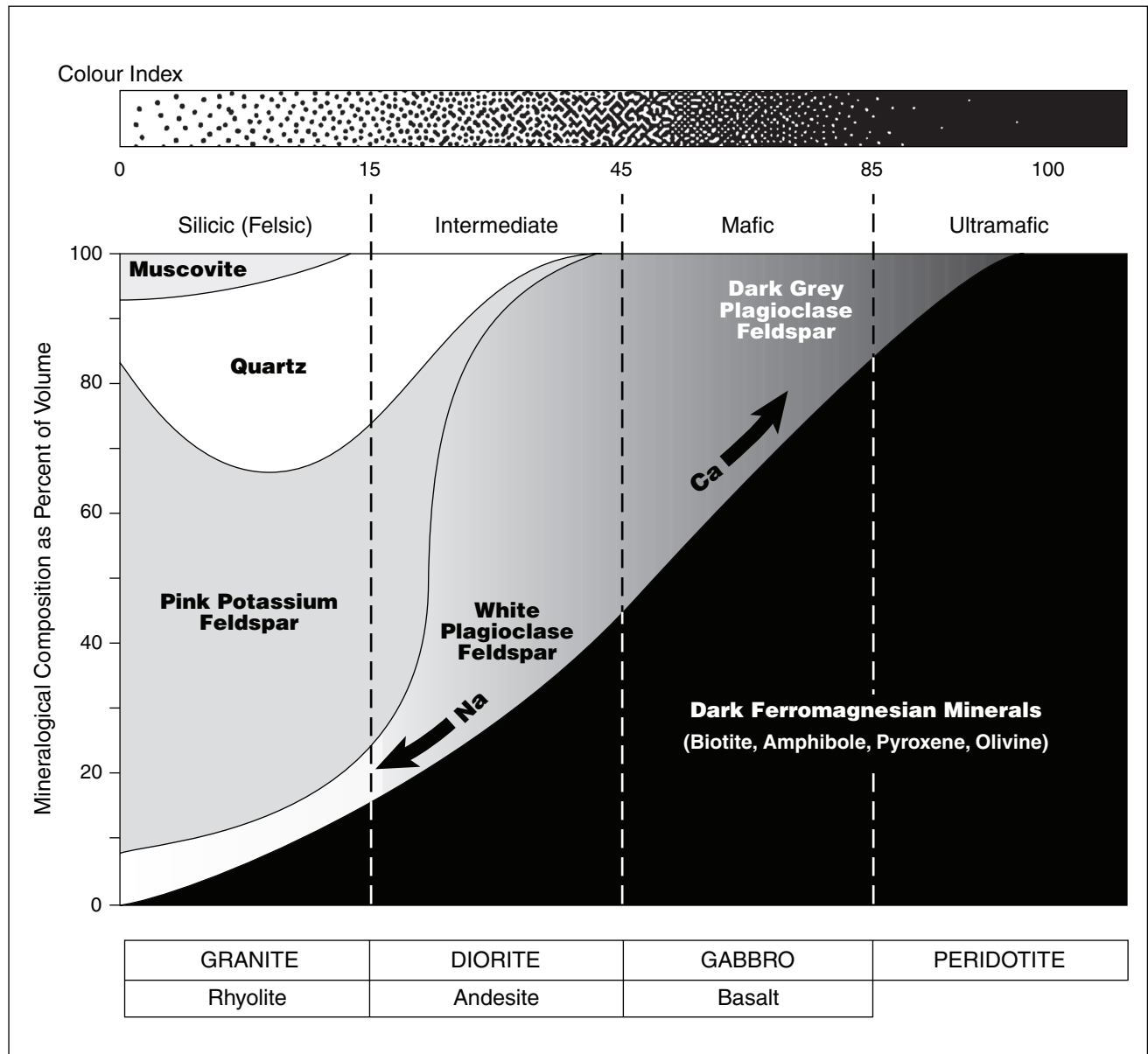


Table of Hardness

Object	Mohs Scale of Hardness
Glass or steel knife	5.5
Wire nail	4.5
Copper penny	3.5
Fingernail	2.5

Properties of Common and Important Minerals

Mineral	Colour	Streak	Lustre	Form and Other Properties	Cleavage	Hardness	Density (g/cm ³)
Amphibole (hornblende)	dark green to black	white-grey	vitreous	long crystals, grains	2 excellent at 56°	6	3.0 – 3.4
Apatite	usually green	white	vitreous	hexagonal crystals	1 poor, conchoidal fracture	5	3.1
Asbestos	green or black	none to white	waxy	fibrous or silky masses	none	2.5 – 5.0	3.1
Azurite	blue	pale blue	earthy–vitreous	earthy mass or tiny crystals, fizzes in acid	seldom visible	3.5 – 4.0	3.8
Bornite	iridescent blue, purple	grey-black	metallic	dense brittle masses	none	3	5.0
Calcite	white, pink or yellow	white-grey	vitreous	rhombohedral crystals, granular, fizzes in acid	3 perfect, not at 90°	3	2.7
Chalcopyrite	golden-brassy yellow	black	metallic	tetrahedral crystals or fine-grained masses	1 poor	3.5 – 4.0	4.2
Chlorite	green to dark green	pale green	vitreous-earthy	scaly masses	1 perfect	2.5	2.6 – 3.3
Feldspar (plagioclase)	white to grey	white	vitreous	tabular crystals, grains	2 excellent at 90°	6	2.6 – 2.8
Feldspar (potassium)	white or pink	white	vitreous-pearly	stubby crystals, grains	2 excellent at 90°	6	2.7
Fluorite	variable: green, purple	white	vitreous	cubic crystals, massive, fluorescent	4 excellent, octahedral	4	3.0 – 3.3
Galena	lead-grey	grey-black	metallic	cubes or massive	3 perfect at 90°	2.5	7.6
Garnet	variable: commonly red	white/pale red	vitreous	12 or 24 faced crystals	none	7	3.6 – 4.0
Gold	gold yellow	yellow	metallic	flakes, grains, malleable	none	2.5 – 3.0	19
Graphite	black	dark grey	metallic	scaly masses, finely crystalline	1 perfect	1 – 2	2.1
Gypsum	colourless or white	white	vitreous to pearly	tabular crystals or finely crystalline	1 excellent, 2 good	2	2.3
Halite	colourless, white	white	vitreous	cubes, finely crystalline, granular, salty taste	3 excellent at 90°	2.5	2.2
Hematite	steel grey, earthy red	red brown	metallic or earthy	scaly or earthy masses	none	1 – 6	5.2
Limonite	brown to yellow	brown	earthy	earthy masses, granular	seldom visible	1 – 5.5	3.0 – 4.0
Magnetite	black	black	metallic	commonly finely crystalline, magnetic	seldom visible	5.5 – 6.5	5.0
Malachite	bright green	pale green	earthy	flakes or earthy masses, fizzes in acid	seldom visible	3.5 – 4.0	3.6 – 4.0
Mica (muscovite)	white, yellow	white	vitreous	flakes, scaly masses	1 perfect	2.0 – 2.5	2.8
Mica (biotite)	black or brown-black	grey, brown	vitreous	flakes, scaly masses	1 perfect	2.5	2.9 – 3.4
Molybdenite	lead grey, bluish tinge	bluish grey	metallic	scaly masses, flakes	1 perfect	1.0 – 1.5	4.7
Olivine	olive green, olive brown	white, grey	vitreous	granular masses, grains	none	6.5	3.3
Pyrite	brass yellow	greenish black	metallic	cubic crystals or finely crystalline	1 very poor	6.0 – 6.5	5.0
Pyroxene (augite)	dark green to black	white-grey	vitreous	stubby crystals	2 excellent at 90°	6	3.3
Pyrrhotite	bronze yellow	grey-black	metallic	finely crystalline, granular, weakly magnetic	none	3.5 – 4.5	4.6
Quartz family includes amethyst, flint, agate	variable: clear, white	white	vitreous	prismatic crystals, granular, some forms are microcrystalline	none – conchoidal fracture	7	2.6
Sphalerite	brown to yellow	yellow to brown	resinous/metallic	tetrahedral crystals, finely crystalline	6 perfect	3.5 – 4.0	4.0
Talc	white	white	silky, greasy	microcrystalline masses, fibrous	1 perfect	1	2.7 – 2.8

Solar System Data Table

Solar System Object	Average Distance to Sun (x 10 ⁶ km)	Equatorial Radius (km)	Mass Relative to Earth (planet mass/Earth mass)	Density (g/cm ³)	Basic Composition	Magnetic Field Strength Relative to Earth	Number of Moons	Average Surface Temperature (°C)	Inclination = orbital angle to ecliptic plane** (degrees)	Rotation Period on axis (hours)
Mercury	57.9	2440	0.055	5.43	silicate & iron	0.01	0	427/–183	7	1407.6
Venus	108.2	6052	0.815	5.24	silicate & iron	none	0	467	3.4	5832.5
Earth	149.6	6378	1.0	5.52	silicate & iron	1.0	1	15	0	23.9
Earth's moon	—	1738	0.012	3.34	silicate & iron	none	—	127/–173	5.1	655.7
Mars	227.9	3397	0.107	3.93	silicate & iron	none	2	–65	1.9	24.6
Asteroid belt	most from 300 to 600 but some close to Earth	range from 1 to 500 km	total mass of all is less than 0.001	varies	silicate & iron	none	at least one asteroid has a moon	—	from 0.5 to 35	from 3 to 417.7
Jupiter	778.6	71 492	317.8	1.33	H and He	13.9	63	–110	1.3	9.9
Saturn	1433.5	60 268	95.2	0.69	H and He	0.68	47	–140	2.5	10.7
Uranus	2872.5	25 559	14.5	1.27	H and He	0.74	27	–195	0.8	17.2
Neptune	4495.1	24 764	17.1	1.64	H and He	0.46	13	–200	1.8	16.1
Pluto*	5870.0	1 195	0.0021	1.75	H and He	unknown	3	–225	17.2	153.3
Kuiper Belt*	4500 to 10 000	range from 1 to 750	0.1	low	rock and ice	unknown	—	–240	varies	—

*Pluto, Sedna and Quaoar are part of the Kuiper Belt of 70 000+ objects that are found outside Neptune's orbit and beyond.

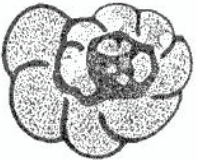

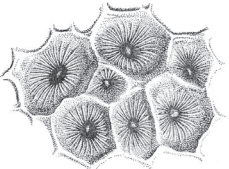
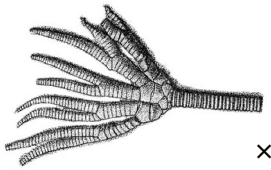
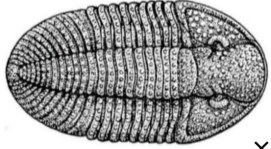
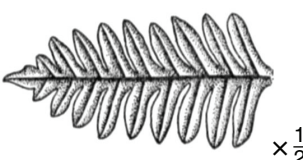


**The ecliptic plane is defined as the imaginary plane containing the Earth's orbit around the Sun.

Data based on 2004 information from NASA – <http://nssdc.gsfc.nasa.gov/planetary/factsheet/>

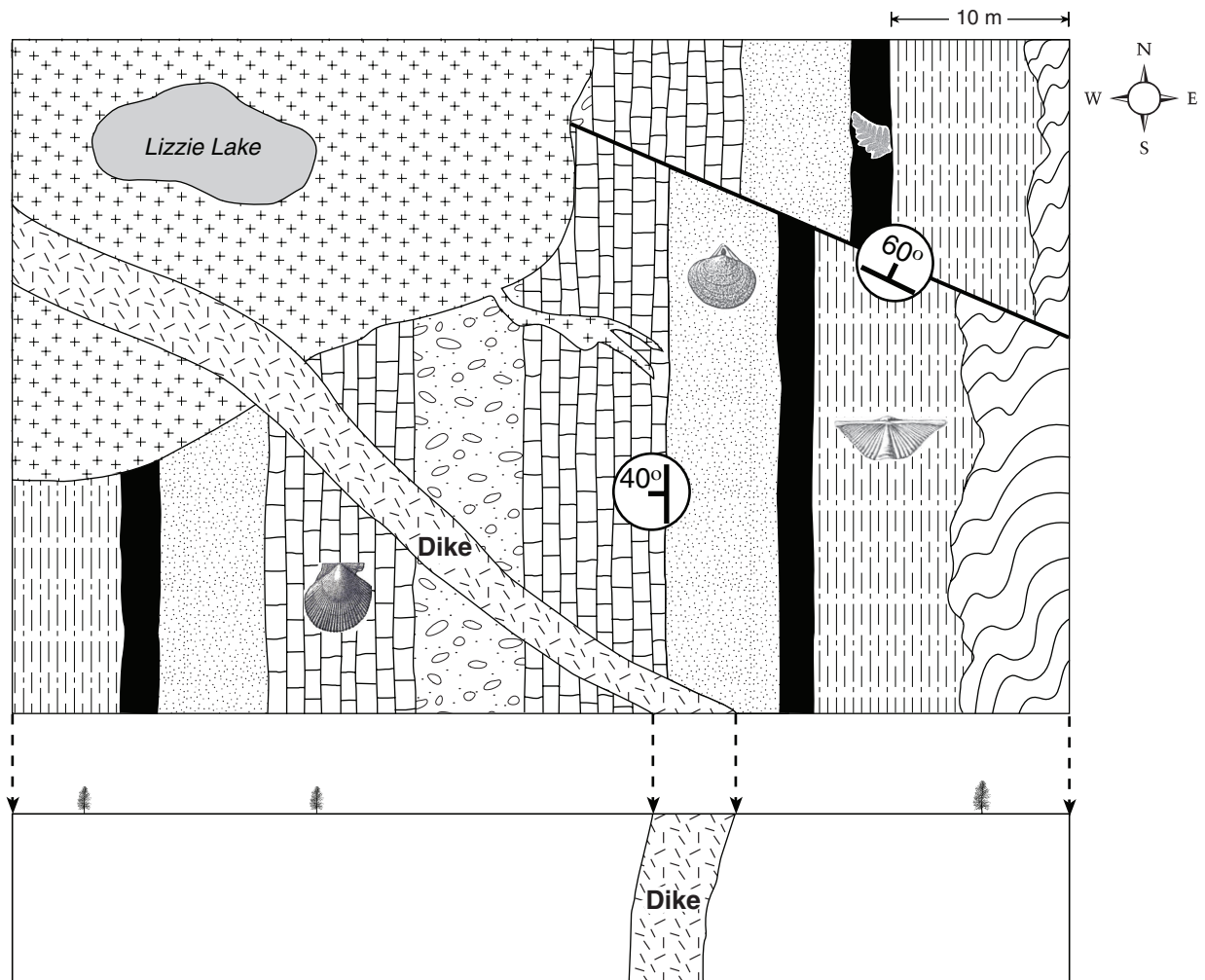
Mississippian Age Rock Outcrops with Fossils

Location R	Location S	Location T	Location U	Location V	Location W
Coal and shale with mudcracks	Limestone	Interbedded shale and sandstone with graded bedding	Shale	Sandstone and siltstone	Sandstone with large scale (4 metre) cross bedding, ripple marks









Mississippian Fossils and their Environments

Fossil Name	Fossil Appearance	Where organism lived	Lifestyle of organism
Foraminiferan	 × 40	surface and upper parts of oceans	free floating
Brachiopod	 × 1	shallow marine	attached
Coelenterata (Colonial coral)	 × $\frac{1}{2}$	shallow marine – maximum depth of approximately 60 metres	attached
Echinodermata (Crinoid)	 × $\frac{1}{2}$	marine – maximum depth of 300 metres	attached
Arthropod (Trilobite)	 × 1	shallow marine	crawling
Plant (Tree fern)	 × $\frac{1}{2}$	swamps and marshes	attached
Mollusc (Bivalve)	 × $\frac{1}{2}$	streams, swamps and lakes	crawling and burrowing
Mollusc (Cephalopod)	 × $\frac{1}{3}$	shallow sea and ocean	swimming

Geological Map



Note: The units below are arranged in random order

	Precambrian metamorphic rock		Sandstone		Conglomerate
	Shale		Diorite		Carbon-rich layer with plant fossils
	Limestone		Granite		

Photographs



— photograph 1 —

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Place Personal Education Number (PEN) here.

Course Code = GEOL 12
AUGUST 2007

Exam Booklet Form/ Cahier d'examen A B C D E F G H
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Student Instructions

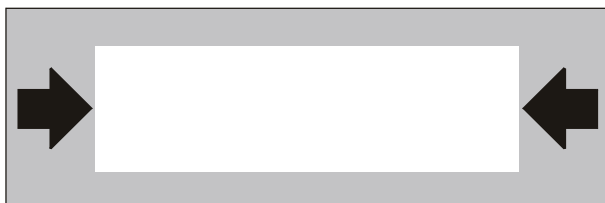
1. Place your Personal Education Number (PEN) label at the top of this Booklet **AND** fill in the bubble (Form A, B, C, D, E, F, G or H) that corresponds to the letter on your Examination Booklet.
2. Use a pencil to fill in bubbles when answering questions on your Answer Sheet.
3. Use a blue- or black-ink pen when answering written-response questions in this Booklet.
4. When the examination begins, remove the Data Pages located in the centre of the Examination Booklet.
5. Read the Examination Rules on the back of this Booklet.

Question 1									
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Question 2									
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Question 3									
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Question 4									
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Question 5									
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Question 6									
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Question 11									
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Course Code = GEOL 12

Geology 12

AUGUST 2007

Response Booklet



The Best Place on Earth

© Province of British Columbia

PART B: WRITTEN RESPONSE

Value: 26 marks

Suggested Time: 40 minutes

INSTRUCTIONS: Answer the following questions in the space provided in the **Response Booklet**.
You may not need to use all of the space given.

Refer to the Percentage of Minerals in Igneous Rocks on page 7,
the Properties of Common and Important Minerals table on page 9, and the
Geological Map on page 13 of the Data Pages to answer question 1.

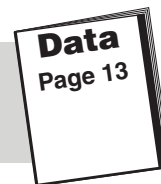
Data
Page 7
Page 9
Page 13

1. The geological map shows a hydrothermal vein that intrudes from granite into the country rock. Inside the vein, there is a rich deposit of a silvery-grey mineral that has good cleavage and a metallic lustre.

Describe a test or observation that could be made to determine if the mineral is galena or molybdenite. Describe the expected difference in results for each of the minerals. (2 marks)

Description of test or observation used to decide if the mineral is galena or molybdenite	Difference in results of test or observation between galena and molybdenite	
	Galena	Molybdenite

**Refer to the Geological Map on page 13 of the Data Pages
to answer question 2.**

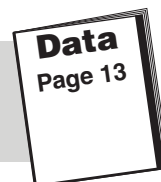


2. Name the metal that is obtained from galena and describe what it is used for. **(2 marks)**

Name of metal: _____

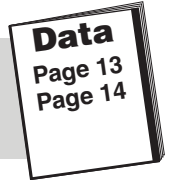
Description of use: _____

**Refer to the Geological Map on page 13 of the Data Pages
to answer question 3.**



3. Describe how hydrothermal activity may produce a galena deposit. **(2 marks)**

**Refer to the Geological Map on page 13 and Photograph 1
on page 14 of the Data Pages to answer question 4.**



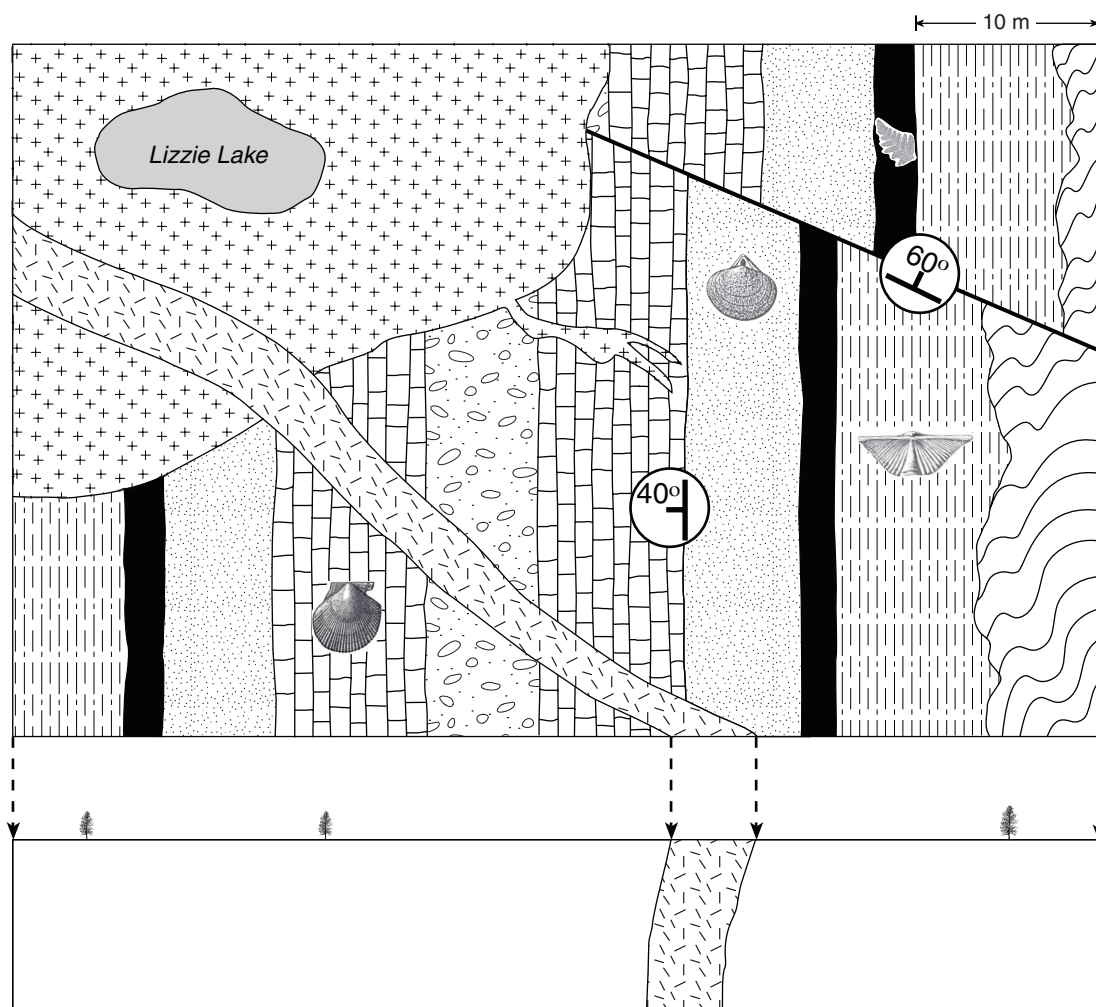
4. Photograph 1 shows the Precambrian metamorphic rock shown on the geological map. The rock contains quartz, feldspar and biotite mica.

Describe the metamorphic rock. In your description include the name of the metamorphic rock, the nature of the parent rock, the physical conditions under which it would have formed, and the type of plate tectonic boundary at which it would have formed. **(4 marks)**









Refer to the Development of Life through Time on page 3,
the Geological Time Scale on page 4, and the Geological Map on page 13
of the Data Pages to answer questions 5 to 7.

Data
Page 3
Page 4
Page 13

Use the following geological map from the Data Pages to answer questions 5 to 7.



Note: The units below are arranged in random order

	Precambrian metamorphic rock		Sandstone		Conglomerate
	Shale		Diorite		Carbon-rich layer with plant fossils
	Limestone		Granite		

5. Draw an accurate cross section in the box provided below the geological map. **(3 marks)**

6. Arrange the following features shown on the geological map in order of their relative ages.
(Features are listed in random order.) **(3 marks)**

- limestone layer
- granite intrusion
- dike
- shale layer
- fold
- fault

<i>youngest</i>	
<i>oldest</i>	

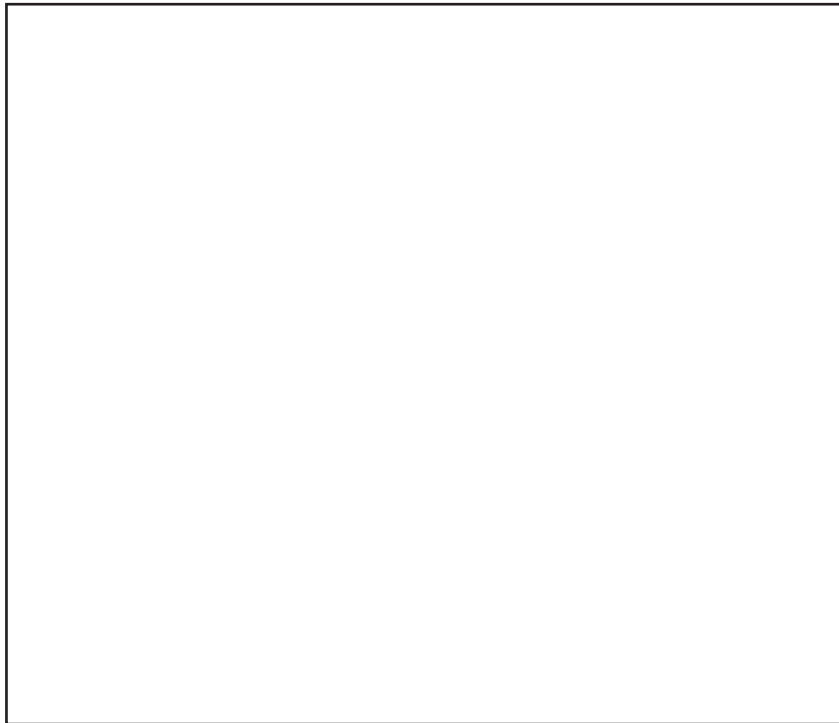
7. A radiometric analysis of potassium-40/argon-40 was made on a sample of one of the rocks in this map area. Describe **two** reasons why the estimated radiometric age of the rock sample might be inaccurate. **(2 marks)**

Reason 1: _____

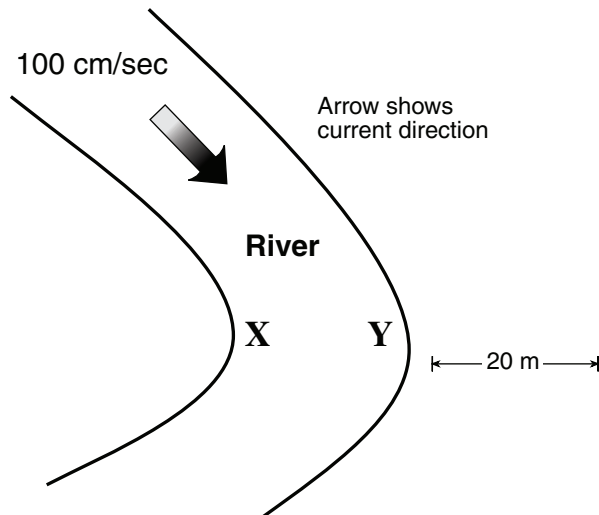
Reason 2: _____

8. The principle of superposition describes a typical situation where younger rock overlies older rock. With the aid of a diagram, describe a geological process that would result in older rock overlying younger rock. **(2 marks)**

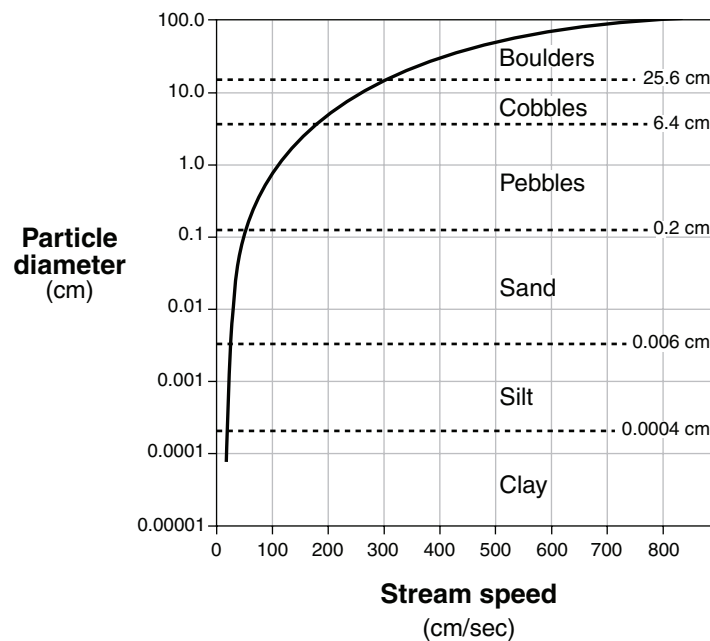
Diagram



Use the following diagrams to answer question 9.

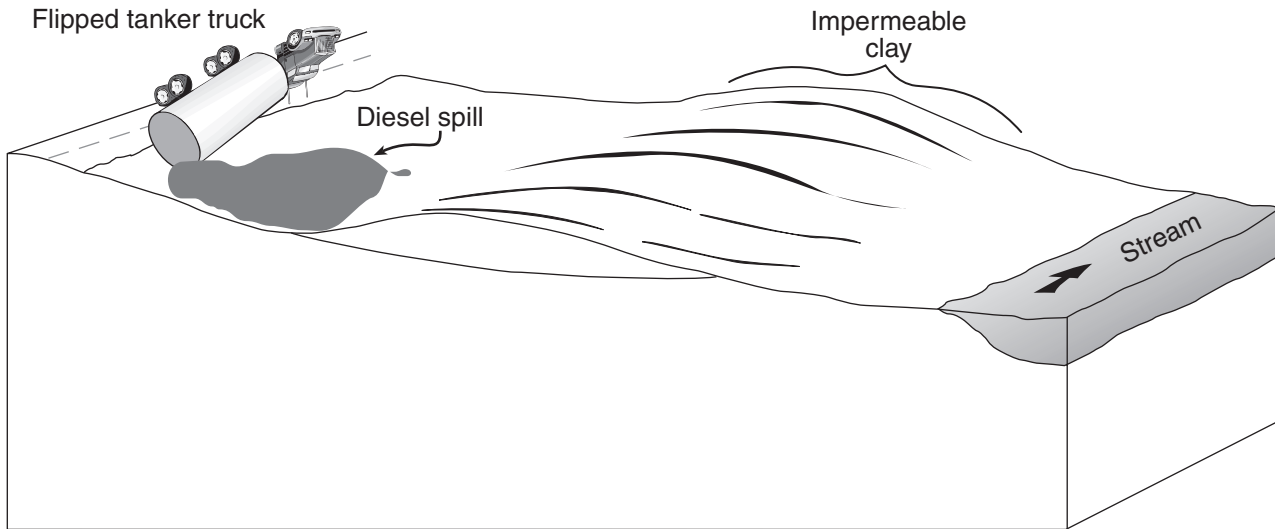


Graph showing particle diameter and stream speed



9. Refer to the diagram and graph and compare the sediment load carried by the river at positions **X** and **Y**, and explain why there is a difference. (2 marks)

Use the following sketch to answer question 10.

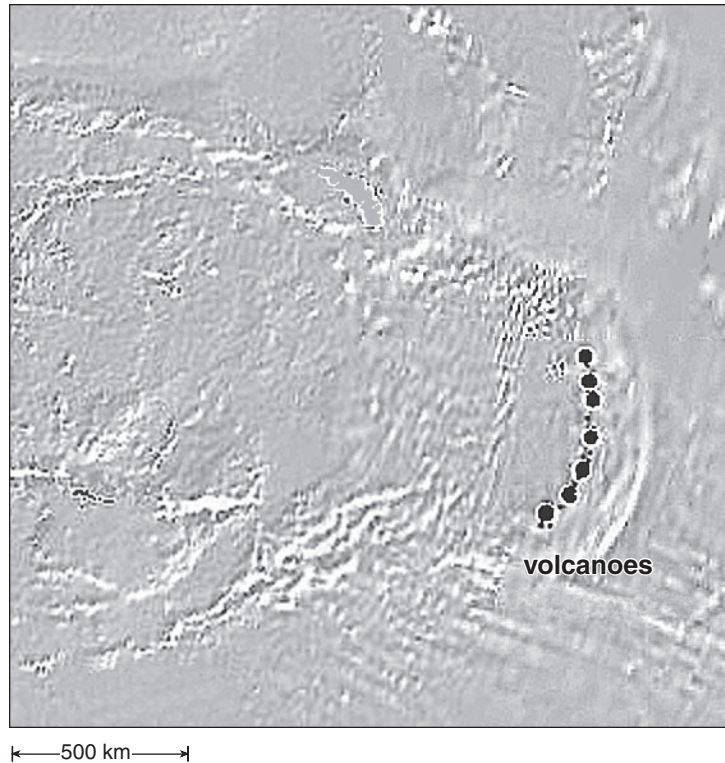


10. The sketch above shows the location of an accident with a fuel tanker. A large quantity of diesel spilled from the tanker and formed a pool against a hill of impermeable shale. In a very short time, biologists discovered fish in a nearby stream were contaminated with diesel.

Complete a labelled cross section showing the subsurface conditions that would be necessary in order for the spilled diesel to pollute the stream. Label any permeable or impermeable layers, as well as the water table.

(2 marks)

Use the following photograph to answer question 11.



11. A spacecraft travelling to another planet returned the image seen above. A geologist identifies a chain of volcanoes from this image. With reference to plate tectonic theory, explain how these volcanoes could have formed and describe what evidence would need to be gathered by a future geological expedition to support your hypothesis. **(2 marks)**

How the volcanoes formed: _____

Description of evidence: _____

END OF EXAMINATION

Examination Rules

1. The time allotted for this examination is two hours.
You may, however, take up to 60 minutes of additional time to finish.
2. Answers entered in the Examination Booklet will not be marked.
3. Cheating on an examination will result in a mark of zero. The Ministry of Education considers cheating to have occurred if students break any of the following rules:
 - Students must not be in possession of or have used any secure examination materials prior to the examination session.
 - Students must not communicate with other students during the examination.
 - Students must not give or receive assistance of any kind in answering an examination question during an examination, including allowing one's paper to be viewed by others or copying answers from another student's paper.
 - Students must not possess any book, paper or item that might assist in writing an examination, including a dictionary or piece of electronic equipment, that is not specifically authorized for the examination by ministry policy.
 - Students must not copy, plagiarize or present as one's own, work done by any other person.
 - Students must immediately follow the invigilator's order to stop writing at the end of the examination time and must not alter an Examination Booklet, Response Booklet or Answer Sheet after the invigilator has asked students to hand in examination papers.
 - Students must not remove any piece of the examination materials from the examination room, including work pages.
4. The use of inappropriate language or content may result in a mark of zero being awarded.
5. Upon completion of the examination, return all examination materials to the supervising invigilator.